



Experience In “Lights Out” Latent Processing

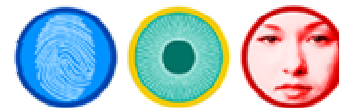
▶ Introduction

- What do we mean by “Lights Out”?
- What are the different technical issues?

▶ What can the technology offer?

- What can be automated?
- What is the impact on accuracy?
 - What is the degradation of accuracy?
 - Is it possible to use quality metrics to predict when automated processing will be accurate?

▶ How can this (non perfect) technology be used to solve more cases?



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April 5-6, 2006
NIST Latent Testing
Workshop



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Introduction

▶ “Lights Out” exists today for Ten Print Person Identification

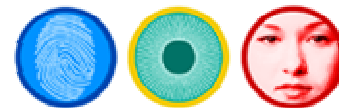
- Fast and fully automated search
- Very selective threshold to eliminate no-hits

▶ In latent processing, human expertise is needed

- Operationally the expert is often the bottleneck of the system
- In most systems, all the latents are not processed
- The result of a search can arrive several days after the evidence collection

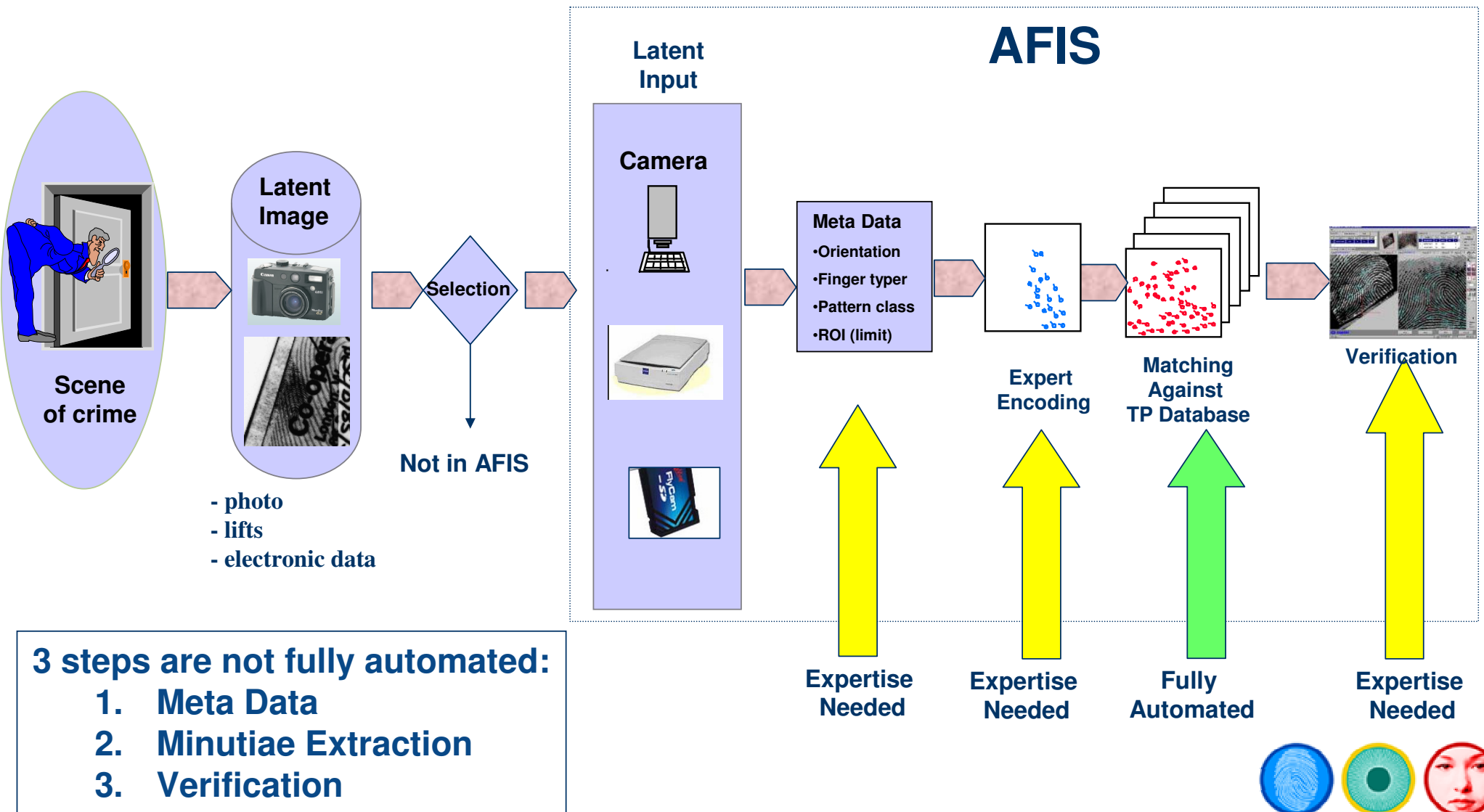
⇒ There is a need for more automation (“Latent Lights Out”)

- Some customers request it (*for example RCMP*)
- Fast and fully automated search
- Very selective threshold to eliminate no-hits
- Fingerprint experts still need to confirm the hits





Latent Processing Workflow



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Step 1: Meta Data

Orientation of the latent	Non oriented matching can be used. Some automation is possible (not presented here)
Finger number	Optional for matching
Pattern classification	Optional for matching Some automation is possible (not presented here)
Latent area	Automatic feature extraction can be done on the full image

=> For each of these operations

- Search can be done without the information (“Brute Force”)
- Some automation is possible

=> Several trade offs (speed / accuracy / automation) are possible



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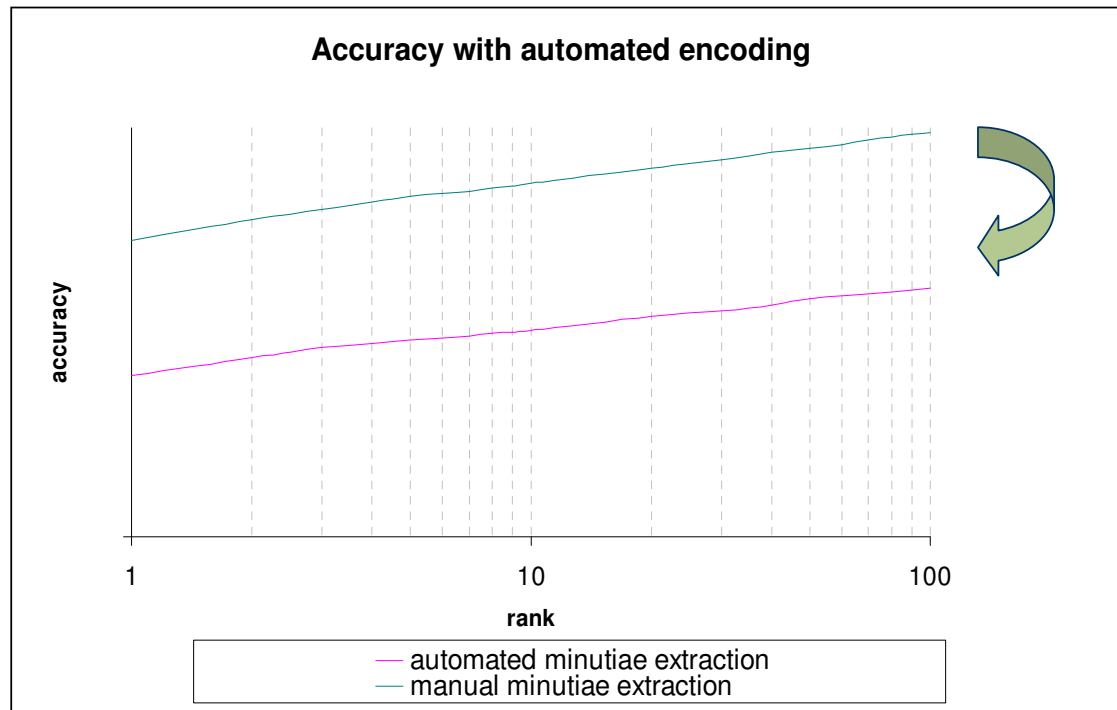
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Step 2 : Minutiae Extraction

Impact of Automated Encoding on Accuracy

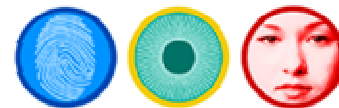
- Latent minutiae encoding is a very time consuming expert task
- Fully automated minutiae extraction can be performed on latents



Accuracy typically decreases
by 10% to 20%
with automated encoding
(depending on latent quality)

Test results on 1350 latents
Background database 1 million fingers

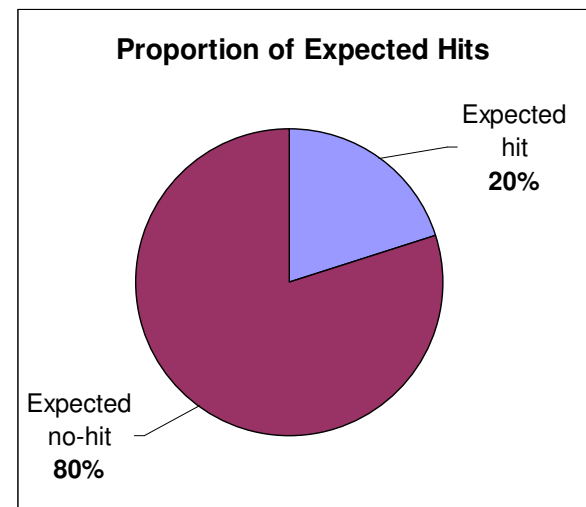
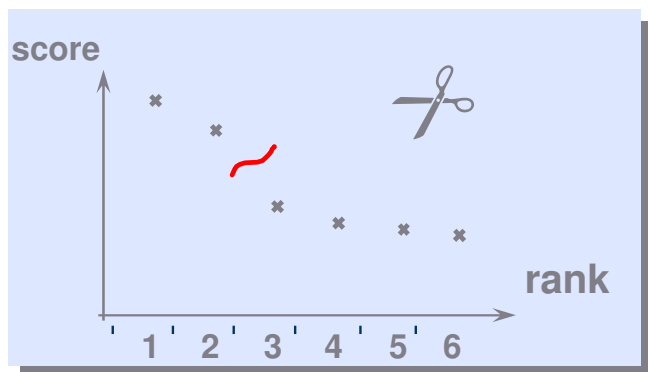
=> Accuracy decreases but –depending on database quality-
many hits are still found





Step 3 : Thresholding Impact on Accuracy

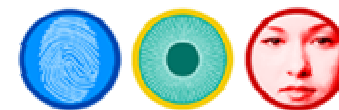
- Most candidates are “expected no-hits”, and they still have to be verified
- Most of the expert time is spent to confirm no-hits, not to confirm hits
- Selective thresholding techniques can be used to eliminate most of the no-hits



Objective of threshold algorithm

- “Expected hits” latents should be over the threshold
to *maximize the accuracy*
- “Expected no-hits” latents should be below the threshold
to *minimize the number of verifications*

- Human verification is still needed to confirm the hits



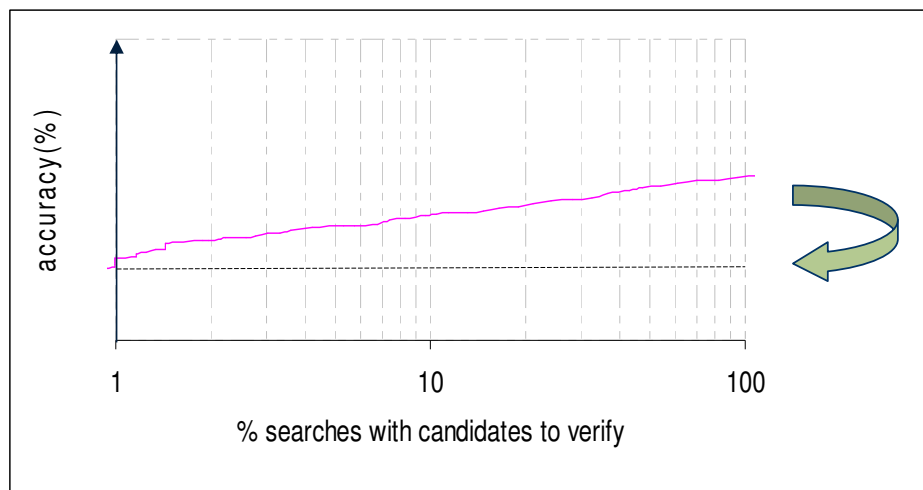
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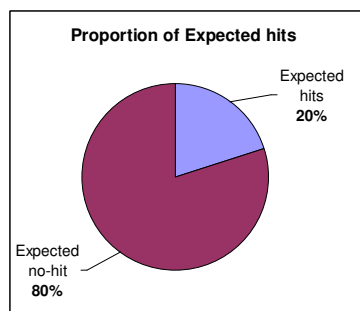
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Step 3 : Thresholding Impact on Accuracy



Accuracy typically decreases
by 5 % to 15%
when threshold is set for 1% verification
(depending on latent quality)

Test results on 1350 latents
Background database 1 million fingers



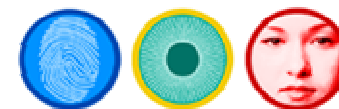
~~For 100 Latent searches~~
For 19 verifications

<u>No Threshold</u>	<u>Threshold</u>	<u>No Threshold</u>
= 100 verifications	= 19 verifications	for 19 verifications
20 hits	18 hits	4 hits
80 no-hits	1 no hit	15 no-hits

When number of verifications is an issue, automated threshold can be used

=> Experts will mainly have to verify hits.

=> Accuracy decreases but many hits are still found



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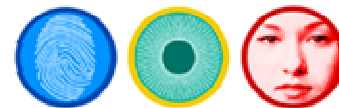
Impact of Automation on Performances Synthesis

⇒ Clearly the expert is more accurate than the machine

But fully automated process can produce additional hits with minimum of effort

⇒ Is there way to use this automation in the operational process ?

⇒ Can be used to improve number of cases solved ...



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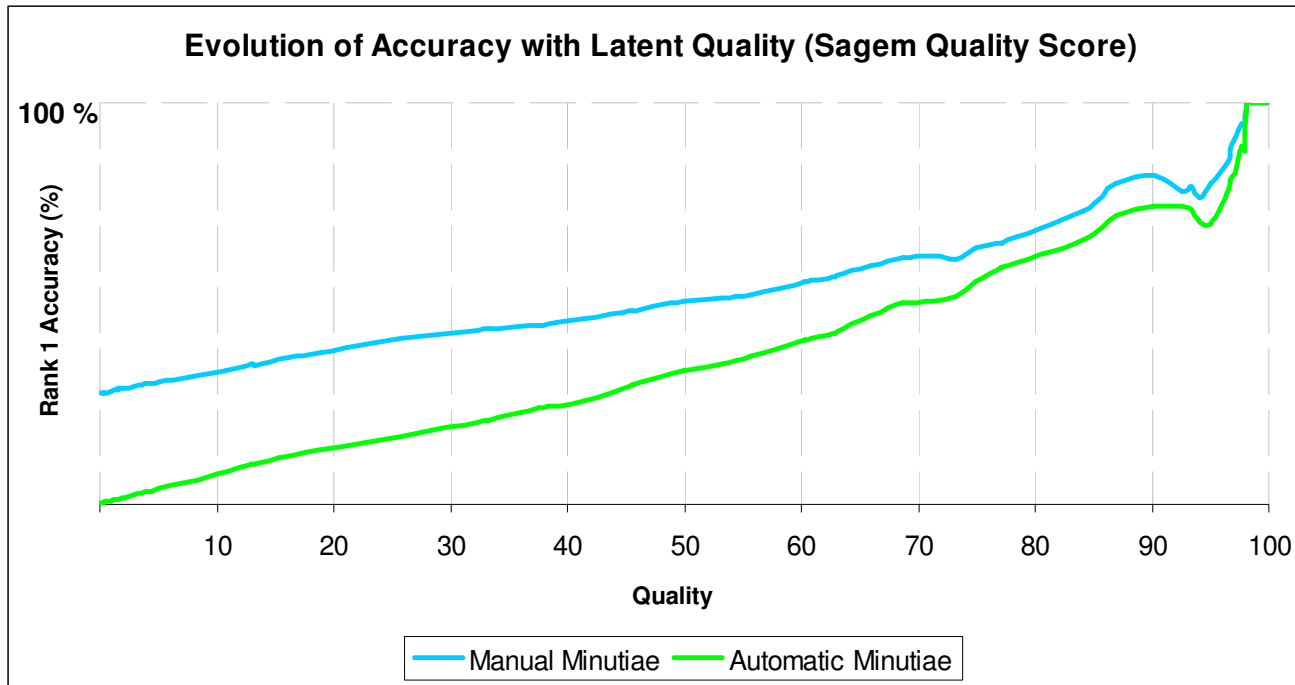
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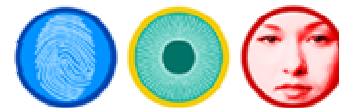
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A Few Comments: Impact of Latent Quality



- Accuracy increases when bad quality Latents are rejected
- Sagem Quality Score (originally designed for Ten Print) correlates well (but not perfectly) to Latent matching accuracy decreases when bad latents are rejected
- Prediction is not good enough yet to guarantee no accuracy loss
- Difference between manual and automatic Minutiae



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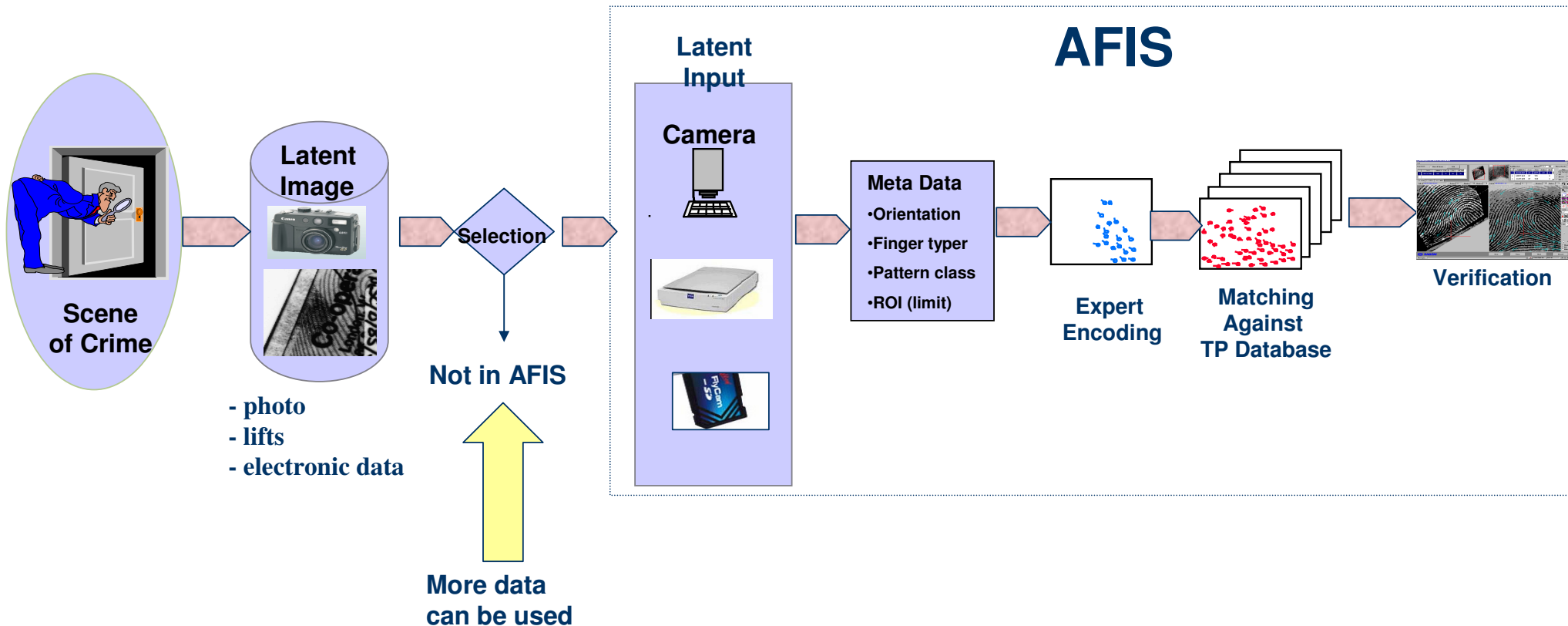


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Automation of Criminal Investigation Processing

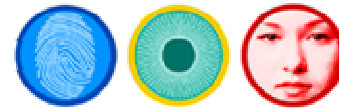
Suggestion 1 : Process more latents with same expert effort

All latents are not always processed today, although some of them are good enough for AFIS



⇒ **Fully automated search could be launched on these latents**

- Very little extra effort for the experts
- More hits found



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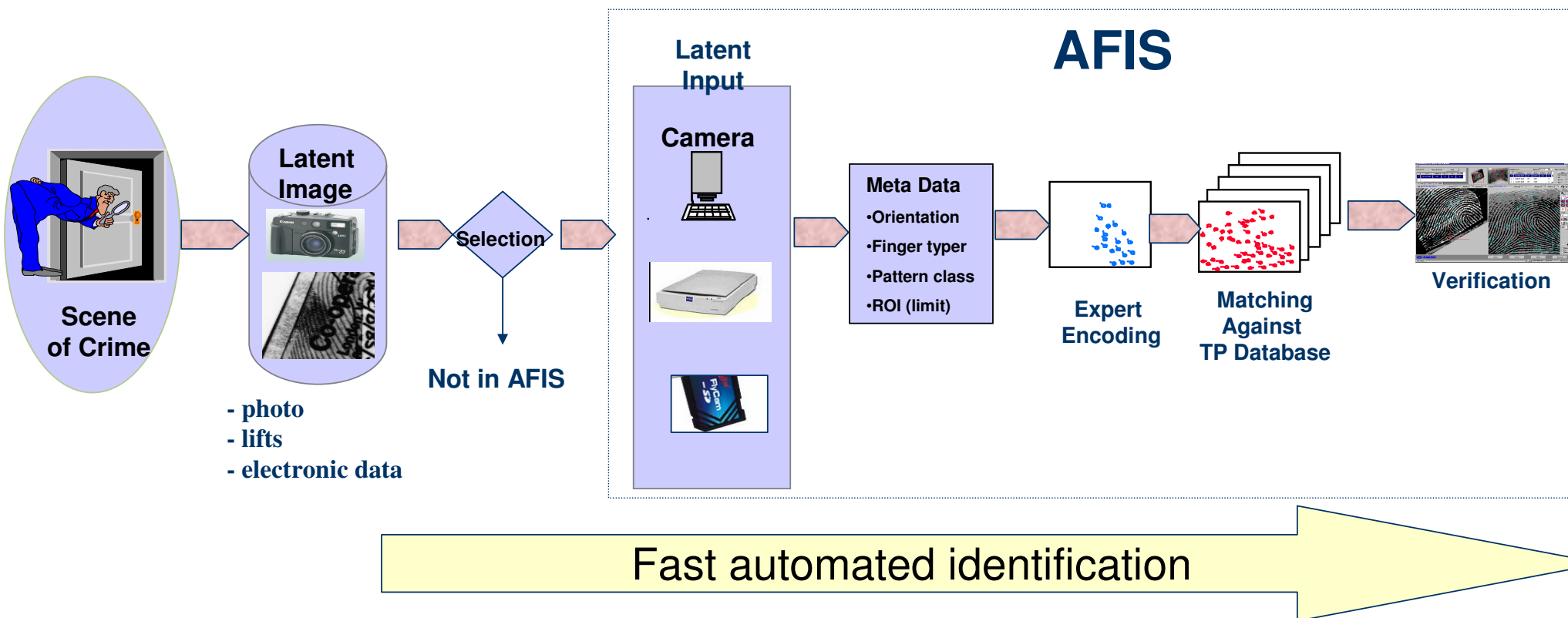


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Automation of Criminal Investigation Processing

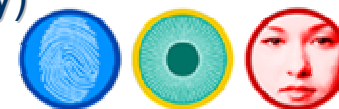


Suggestion 2 : Immediate feedback to investigator



⇒ **When fast feedback is needed, automatic search can be launched first**

- Manual process may be launched too (=> no loss of accuracy)
- Allows improved efficiency in investigation



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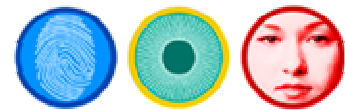
■ ■ ■ ■ ■ Automation of Criminal Investigation Processing

Suggestion 3 : Automatically process good quality latents

- Clear fingerprint marks with lots of visible minutiae
 - Large area latents
 - Needs further study to improve Latent Quality Measurement
- => The expert could concentrate on more difficult latents

Suggestion 4 : Processing latents from paper archive

- “Bulk” scan by non expert operators
- Automatic minutiae encoding
- Selective threshold
- Very few verifications to perform, mostly hits.



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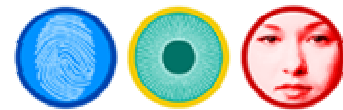


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Experience in Latent “Lights Out” Processing

- **Fully automated process is possible**
 - Automated feature extraction
 - Very selective threshold
 - Accuracy is lower but many hits are still found
- **Automated process is not as accurate as the expert and cannot replace human expertise**
- **In some scenarios, automation can be used to solve more cases**



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